Chapter 11: Study of Animal Type : Cockroach

EXERCISE [PAGE 137]

Exercise | Q 1. (A) | Page 137
Choose the correct option.
Chemical nature of chitin is _____.

a. protein
b. carbohydrate
c. lipid
d. glycoprotein

SOLUTION

b. carbohydrate and d. glycoprotein

Exercise | Q 1. (B) | Page 137
Choose the correct option.
Cockroach has _____ type of mouthparts.

1. sponging
2. **chewing and biting**
3. piercing and sucking
4. lapping

SOLUTION

Cockroach has **chewing and biting** type of mouthparts.

Exercise | Q 1. (C) | Page 137
Choose the correct option.
Spiracle is a part of _____ system of cockroach.

1. circulatory
2. **respiration**
3. reproductive
4. nervous

SOLUTION

Spiracle is a part of **respiration** system of cockroach.

Exercise | Q 1. (D) | Page 137
Choose the correct option.
_____ is a part of digestive system.

1. Trachea
2. **Hypopharynx**
3. Haemocyte
4. Seminal vesicle

SOLUTION

Hypopharynx is a part of digestive system.

Exercise | Q 1. (E) | Page 137
Choose the correct option.
_____ is also called as brain of cockroach.

1. **Supra-oesophageal ganglion**
2. Sub-oesophageal ganglion
3. Hypo-cerebral ganglion
4. Thoracic ganglion

SOLUTION

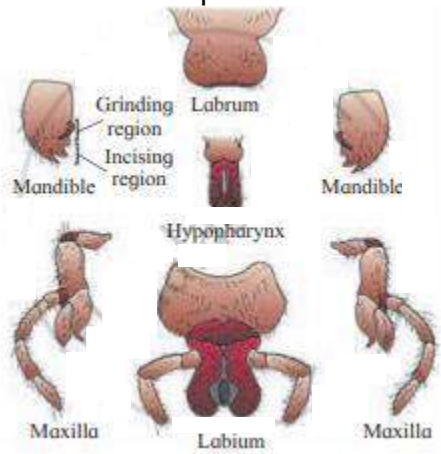
Supra-oesophageal ganglion is also called as brain of cockroach.

Exercise | Q 2. (A) | Page 137
Answer the following question.
Describe the digestive system of cockroach.

SOLUTION

- Digestive system of cockroach consists of mouthparts, alimentary canal and salivary glands.

- **Mouthparts:** Pre-oral cavity present in front of the mouth receives food. It is bounded by chewing and biting type of mouth parts. These are movable, segmented appendages that help in the ingestion of food. The mouthparts of cockroach comprises of:



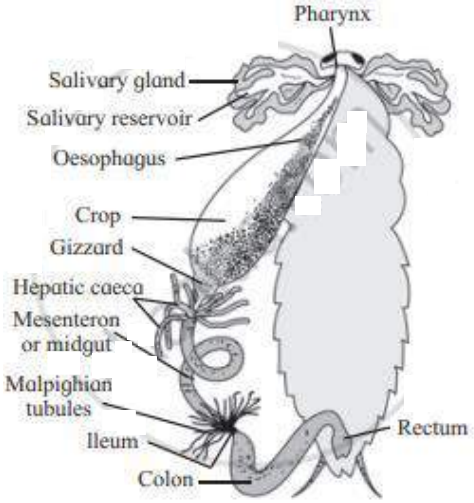
Mouthparts of cockroach

1. **Labrum:** It forms the upper lip. It is a single flap-like movable part which covers the mouth from upper side. It forms an anterior wall of preoral cavity.
   Function: It is useful in holding the food during feeding.
2. **Mandibles:** These are two dark, hard, chitinous structures with serrated median margins. They are true jaws present on either side, behind the labrum.

Function: They perform co-ordinated side-wise movements with the help of adductor and abductor muscles to cut and crush the food.

3. **Maxillae:** These are the accesssory jaws. They are also called as first pair of maxillae. These are situated on either side of the mouth behind the mandibles. Each maxilla consists of sclerites like cardo, stipes, galea, lacinia and maxillary palps.
   Functions: Maxillae hold food, help mandibles for mastication. They are also used for cleaning the antennae and front legs. Maxillary palps act as tactile organs.
4. **Labium:** It forms the lower lip. Labium is also known as the second maxilla which covers the pre-oral cavity from the ventral side. It is firmly attached to the posterior part of the head. It has three jointed labial palps which are sensory in function.
   Function: It is useful in pushing the chewed food in the pre-oral cavity. It prevents the loss of food falling from the mandibles, while chewing.
5. **Hypopharynx:** Hypopharynx is also known as a lingua. It is a somewhat cylindrical single structure, located in front of the labium and between the first maxillae. The salivary duct opens at the base of the hypopharynx. Hypopharynx bears comb-like plates called super-lingua on either side. Hypopharynx is present at the center of the mouth.
   Function: It is useful in the process of feeding and mixing saliva with food.

- **Alimentary canal:** It is long a (6 - 7cm) tube of different diameters with two openings.
- The alimentary canal is divisible into three parts: foregut, midgut and hindgut.



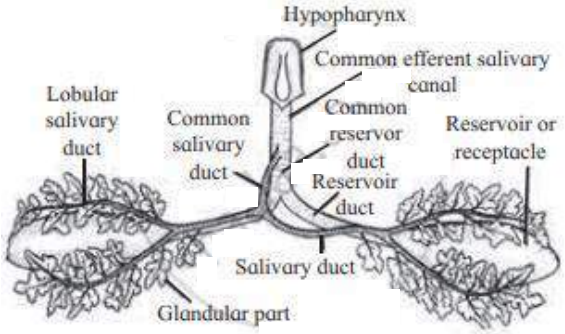
1. **Foregut or stomodaeum:** It consists of pharynx, oesophagus, crop and gizzard.
   a. Pharynx: It is a very short, narrow but muscular tube that opens into oesophagus.
   Function: Conduction of food into the oesophagus.
   b. Oesophagus: It is a slightly long and narrow tube which opens into crop.
   c. Crop: Crop is a large, pear shaped and saclike organ.
   Function: It temporarily stores the food and then sends it to gizzard.
   d. Gizzard: Gizzard or proventriculus is a small spherical organ. It is provided internally with a circlet of six chitinous teeth and backwardly directed bristles.The

foregut ends with gizzard.
Function: The chitinous teeth present in gizzard are responsible for crushing the food and the bristles help to filter the food.

2. **Midgut or mesenteron:** It consists of stomach and hepatic caeca.
   a. Ventriculus or stomach: It is straight, short and narrow. Stomach is lined by glandular epithelium which secretes digestive enzymes.
   Function: It is mainly responsible for digestion and absorption.
   b. Hepatic caeca: These are thin, transparent, short, blind (closed) and hollow tubules.
   Function: They secrete digestive enzymes.
3. **Hindgut or proctodaeum:** It consists of ileum, colon and rectum.
   a. Ileum: It is short and narrow part of hindgut. Malpighian tubules open in the anterior lumen of ileum, near the junction of midgut and hindgut. Posterior region of ileum contains sphincter. Ileum directs the nitrogenous wastes and undigested food towards colon.
   b. Colon: It is a longer and wider part of the hindgut. It directs waste material towards the rectum. It reabsorbs water from wastes as per the need.
   c. Rectum: It is oval or spindle-shaped, terminal part of the hindgut. It contains six rectal pads along the internal surface for absorption of water. Rectum opens into anus. Anus is present on the ventral side of the 10th segment. It is the last or posterior opening of the digestive system. The undigested food is released out of the body through the anus.

- **Salivary glands:**

1. Cockroach has a pair of salivary glands which secrete saliva.
2. Each salivary gland has two glandular lobes and a receptacle or reservoir.
3. The glandular lobes consist of several irregular-shaped white coloured lobules which secrete saliva.
4. Each gland has a salivary duct. Both the ducts unite to form a common salivary duct.
5. The receptacle of each salivary gland is thin-walled, elongated, sac-like structure. Each receptacle has a duct. These ducts unite to form a common reservoir duct.
6. Common salivary duct and common reservoir duct unite together to form a common efferent salivary duct. The efferent salivary duct opens at the base of tongue or hypopharynx.

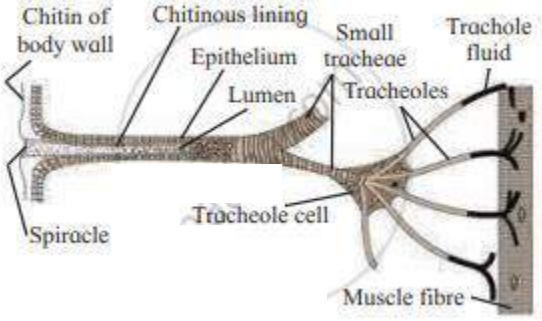


Exercise | Q 2. (B) | Page 137

Answer the following question.
Give an account on the tracheal system of cockroach.

SOLUTION

1. A cockroach has an internal respiratory system of air tubes called tracheal system by which the air is brought into the body and is in contact with every part of the body. It allows the exchange of gases directly between the air and tissues without the need of blood. These air tubes of the internal respiratory system begin at the opening on body surface called spiracles.



2. **Spiracles:** They are paired respiratory openings. Spiracles are present on the ventro-lateral side of the body, in the pleural membrane. Cockroaches have two pairs of thoracic and eight pairs of abdominal spiracles. The spiracles open into a series of air sacs from which arise the tubes called trachea. The spiracles let the air into and out of the trachea.
3. **Trachea:** The trachea form a definite pattern of branching tubes arranged transversely as well as longitudinally. They are about 1mm thick and have spiral or annular thickening of chitin. The inner lining of chitin prevents the trachea from collapsing. Each trachea further branches into smaller tubes called tracheoles.
4. **Tracheoles:** These are fine intracellular tubes that penetrate deep into tissues. They are thin and not lined by chitin. They end blindly in the cells. Each tracheole at the blind end is filled with a watery fluid through which the exchange of gases takes place. The content of this fluid keeps changing. At the high muscular activity, part of fluid part is drawn into the tissues to enable more and rapid oxygen intake.

Exercise | Q 2. (C) | Page 137

Answer the following question.
Describe the nervous system of cockroach.

SOLUTION

Nervous system in cockroach:
Nervous system of cockroach is ventral, solid, and ganglionated. It consists of central nervous system (CNS), peripheral nervous system (PNS), and autonomous nervous system (ANS).

Central nervous system (CNS): Central nervous system consists of nerve ring and ventral nerve cord.

- **Nerve ring consists of:**

1. **Supra-oesophageal ganglia or cerebral ganglia:**
   A pair of supra-oesophageal ganglia is collectively known as the brain. Brain is present in head, above the oesophagus and between antennal bases. Each supra-oesophageal ganglion is formed by the fusion of three small ganglia - protocerebrum, deutocerebrum and tritocerebrum.
2. **Circum-oesophageal connectives:**
   Supra-oesophageal ganglia are connected to sub-oesophageal ganglion by a pair of lateral nerves called as circum-oesophageal connectives. Connectives arise from supra-oesophagial ganglia.
3. **Sub-oesophageal ganglia:**
   It is bilobed and present below the oesophagus, in the head. It is also formed by the fusion of three pairs of ganglia.

- **Ventral nerve cord:**

1. It arises from the sub-oesophageal ganglion. It is present along the mid-ventral position, in perineural sinus.
2. It is double ventral nerve cord and consists of nine segmental, paired ganglia.
3. First three pairs of segmental ganglia are large and known as thoracic ganglia. The other six pairs of segmental ganglia are in the abdomen (abdominal ganglia).
4. 6th abdominal ganglion is the largest and it is present in 7th abdominal segment.
5. There is no ganglion in 6th segment.

The peripheral nervous system (PNS):

1. The peripheral nervous system comprises of nerves that arise from various ganglia of CNS.
2. Six pairs of nerves arise from the supra-oesophageal ganglia.They supply to the eyes, antenna and labrum.
3. Nerves arising from the sub-oesophageal ganglion supply to the mandibles, maxillae and labium.
4. Nerves arising from the thoracic ganglia supply to the wings, legs and internal thoracic organs.
5. Nerves from abdominal ganglia go to the abdominal organs of respective abdominal segments.

The autonomic nervous system (ANS):
It consists of four ganglia and a retrocerebral complex.
The ganglia are as follows:

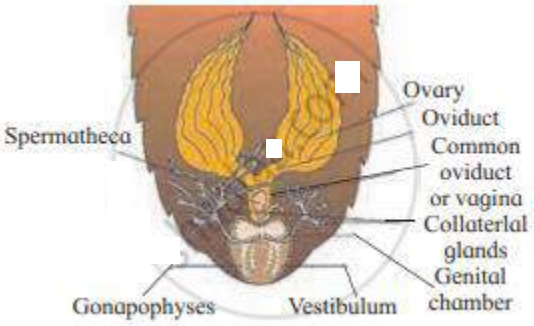
1. **Frontal ganglion:** It is present above the pharynx and in front of the brain.
2. **Hypocerebral ganglion:** It is present in the anterior region of oesophagus.
3. **Ingluvial ganglion:** It is present on crop. It is also called as visceral ganglion.
4. **Ventricular ganglion:** It is present on gizzard.

Exercise | Q 2. (D) | Page 137
Answer the following question.

With help of a neat labelled diagram, describe the female reproductive system of cockroach.

SOLUTION

1. Female reproductive system of cockroach consists a pair of ovaries, a pair of oviducts, a vagina, spermatheca, and accessory glands.
2. Ovaries are primary reproductive organs. They are paired and lie laterally in position in 2^{nd} - 6^{th} abdominal segments. Each ovary is formed of a group of 8 ovarian tubules or ovarioles, containing a chain of developing ova. All ovarioles of an ovary open in the lateral oviduct of the respective side.



3. The lateral oviducts unite to form a common oviduct or vagina. Common oviduct or vagina opens into the Bursa copulatrix (genital chamber), the female organ of copulation.
4. Spermatheca, is a sperm storing structure present in the 6th segment that opens into the genital chamber. It receives the sperms during copulation and stores them for fertilization.
5. Collaterial glands are accessory paired glands that open in the genital chamber.
6. Female gonapophyses consist of six chitinous plates surrounding the genital pore.

Exercise | Q 2. (E) | Page 137

Answer the following question.
Describe the digestive system of cockroach.

SOLUTION

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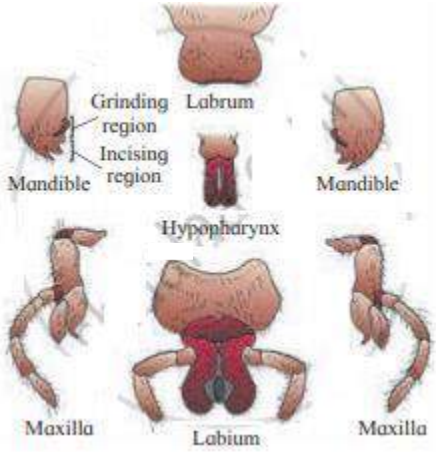

Mouthparts of cockroach

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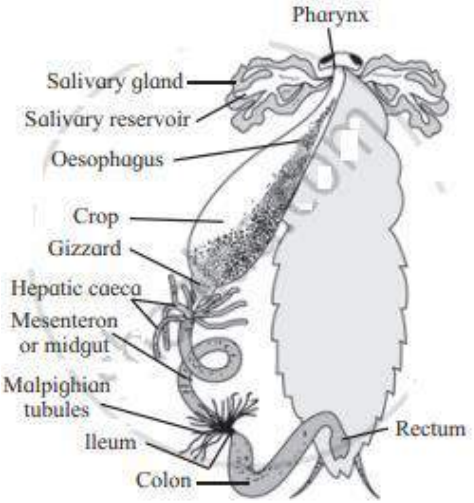

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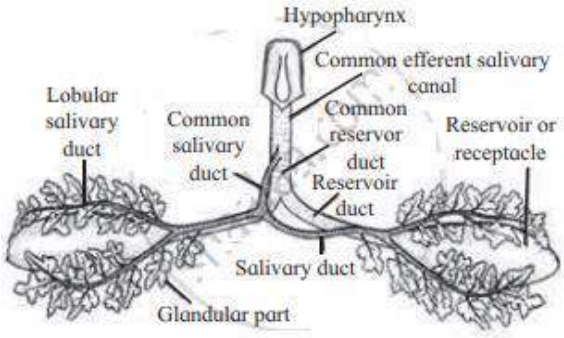


Exercise | Q 2. (F) | Page 137

Answer the following question.
A student observed that the cockroaches are killed for dissection by simply putting them in soap water. He inquired whether soap is so poisonous. Teacher said it is due to its peculiar respiratory system. How?

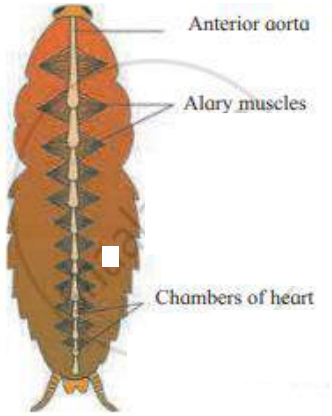
SOLUTION

Cockroaches when put in a soap solution, the solution enters into their body through the small respiratory openings called spiracles. The spiracles lead to trachea which further branches into smaller tubes called tracheoles. Each of these tracheoles has body fluid which acts as a stationary medium for diffusion. The soap solution rapidly diffuses through the entire respiratory system which may result in suffocation and eventually lead to the death of cockroach.

Exercise | Q 2. (G) | Page 137

Answer the following question.
Describe the circulatory system of cockroach.

SOLUTION



- A cockroach has open circulatory system. It consists of colourless blood (haemolymph), a dorsal blood vessel (heart and dorsal aorta) and haemocoel.
- **Haemolymph:** Haemolymph is colourless as it is without any pigment. It consists of plasma and seven types of blood cells/haemocytes. Plasma consists of water with some dissolved organic and inorganic solutes. It is rich in nutrients and nitrogenous wastes like uric acid.
- **Haemocoel:** The body cavity of cockroach (haemocoel) can be divided into three sinuses due to two diaphragms i.e. dorsal and ventral diaphragm. These diaphragms are thin, fibromuscular septa (sing.septum) which remain attached to terga along lateral sides at intermittent points.

a. **Dorsal diaphragm:** It has 12 pairs (10 abdominal and 2 thoracic) of fan-like alary muscles. Alary muscles are triangular with pointed end attached to terga at lateral side and broad end lies between the heart and dorsal diaphragm.

b. **Ventral diaphragm:** It is flat and present just above the ventral nerve cord. Laterally, it is attached to sterna at intermittent points.

c. **Sinuses:** The coelom of cockroach is divided into three sinuses – pericardial sinus, perivisceral sinus and perineural sinus.

   1. Pericardial sinus: It is dorsal, very small and contains a dorsal vessel.

   2. Perivisceral sinus: It is the middle and largest sinus. It contains fat bodies and almost all major visceral organs of the alimentary canal and reproductive system.

   3. Perineural sinus: It is ventral, small and contains ventral nerve cord. It is continuous into legs. All the three sinuses communicate with each other through the pores present between two successive points of attachments of diaphragms.

- **Dorsal blood vessel:** This is present in the pericardial sinus, just below the tergum. It is divisible into the posterior heart and anterior aorta (dorsal aorta/cephalic vessel).

a. **Heart:** It is about 2.5 cm long, narrow, muscular tube that is open anteriorly and closed posteriorly. It starts from 9th abdominal segment and extends anteriorly up to 1st thoracic segment. Heart of cockroach is 13 chambered, out of which 10 chambers are in the abdominal region and 3 chambers are in the thoracic region. Each chamber has a pair of vertical slit-like incurrent aperture or opening called

ostium (plural: ostia). Ostia are present along the lateral side in the posterior region of the first 12 chambers. Each ostium has lip-like valves that allow the flow of blood from sinus to heart only.

b. **Anterior aorta:** Heart is continued by a short, thin-walled vessel called the dorsal aorta. It lies in the head region and opens in the haemocoel.

Exercise | Q 3. (A) | Page 137

Answer the following question.
How will you identify male or female cockroach?

SOLUTION

Male and female cockroach can be identified with the help of the following differences:

- **Male cockroach-**

1. Abdomen is relatively long and narrow.
2. 7^{th} tergum covers 8^{th} tergum.
3. Antennae are longer in size.
4. Anal styles are present.
5. Brood pouch is absent.
6. All 9 sterna visible.

- **Female cockroach-**

1. Abdomen is short and broad.
2. 7^{th} tergum covers 8^{th} and 9^{th} terga.
3. Antennae are shorter in size.
4. Anal styles are absent
5. Brood pouch is present.
6. Only 7 sterna visible.

Exercise | Q 3. (B) | Page 137

Answer the following question.
Write a note on the Gizzard of cockroach.

SOLUTION

Gizzard or proventriculus is a small spherical organ. It is provided internally with a circlet of six chitinous teeth and backwardly directed bristles. The foregut ends with a gizzard.

Function: The chitinous teeth present in the gizzard are responsible for crushing the food and the bristles help to filter the food.

Exercise | Q 3. (C) | Page 137

Answer the following question.
Give the systematic position of cockroach.

SOLUTION

Systematic position of cockroach:

Classification		Reasons
Kingdom	Animalia	Cell wall absent, heterotrophic nutrition.
Phylum	Arthropoda	They have jointed appendages. Body is chitinous and segmented.
Class	Insecta	They possess two pairs of wings and three pairs of walking legs.
Genus	Periplaneta	Straight wings and nocturnal.
Species	americana	Originated in the continent of America.

Exercise | Q 3. (D) | Page 137

Answer the following question.
What would have happened if the cockroach did not had gizzard?

SOLUTION

1. The gizzard in cockroach is a spherical organ which has chitinous teeth and bristles.
2. The chitinous teeth present in the gizzard are responsible for crushing the food and the bristles help to filter the food.
3. If the cockroach did not have a gizzard, the food will not be crushed into small particles and unfiltered food will enter the hindgut. Thus, digestion will be affected in the absence of a gizzard.

Exercise | Q 3. (E) | Page 137

Answer the following question.
What is the functional difference between eyes of cockroach and human being?

SOLUTION

1. Cockroaches have compound eyes whereas humans have simple eyes.
2. Eyes of cockroach possess several ommatidia that collectively form an image and help them to detect even the slightest movement of its predator. They provide a mosaic or hazy vision.

3. Human eyes contain a single lens and a clear image is formed on the retina. Humans have binocular vision which provides an improved perception of depth and gives a three-dimensional image of their surroundings.

Exercise | Q 3. (F) | Page 137

Answer the following question.
What is the functional difference between the respiratory systems of cockroach and human being?

SOLUTION

The functional difference between the respiratory systems of cockroach and human being is that in the respiratory system of cockroach transport of gases does not occur via. blood whereas in the human respiratory system transport of gases takes place via blood. In cockroach, the circulatory system has no role in the respiratory process whereas in humans, the circulatory system plays an important in the respiratory process.

Exercise | Q 4. (A) | Page 137

Explain the following in short:
What are anal cerci?
SOLUTION

1. Anal cerci are a pair of appendages at the end of the abdomen that arise from the 10th segment of the body of both male and female cockroach.
2. They are sensitive to wind movements and detect vibrations.

Exercise | Q 4. (B) | Page 137

Explain the following in short.
What is a ganglion?

SOLUTION

1. A ganglion is a group of nerve cell bodies.
2. It represents the brain in advanced invertebrates.

Exercise | Q 4. (C) | Page 137

Explain the following in short.
What is the role of the hypopharynx?

SOLUTION

Hypopharynx is also known as a lingua. It is a somewhat cylindrical single structure, located in front of the labium and between the first maxillae. The salivary duct opens at the base of the hypopharynx. The hypopharynx bears comb-like plates called super-lingua on either side. Hypopharynx is present at the center of the mouth.
Function: It is useful in the process of feeding and mixing saliva with food.

Exercise | Q 4. (D) | Page 137

Explain the following in short:
What is mesentron?

SOLUTION

Midgut or mesenteron: It consists of the stomach and hepatic caeca.

1. **Ventriculus or stomach:** It is straight, short, and narrow. The stomach is lined by glandular epithelium which secretes digestive enzymes.

   Function: It is mainly responsible for digestion and absorption.
2. **Hepatic caeca:** These are thin, transparent, short, blind (closed) and hollow tubules.
   Function: They secrete digestive enzymes.

Exercise | Q 4. (E) | Page 137

Explain the following in short:
Location of turgum

SOLUTION

1. Tergum is a chitinous plate located in the abdomen of a cockroach.

2. The abdomen is elongated and made up of ten segments. Each segment has a dorsal tergum and ventral sternum.

3. Tergum is jointed to the sternum laterally by a soft cuticle called pleura.

Exercise | Q 4. (F) | Page 137

Explain the following in short:
What is ootheca?

SOLUTION

1. The secretion of collaterial glands forms a capsule around them is called an ootheca or egg case.
2. It is about 8 mm long and ranges from dark reddish to blackish brown.
3. Ootheca contains 14 to 16 fertilized eggs in two rows.
4. They are dropped or glued to a suitable surface, like a crack or crevice with good humidity near a food source.
5. A female cockroach on average produces 9 to 10 oothecae during its lifespan.

Exercise | Q 4. (G) | Page 137

Explain the following in short:
How many chambers are present in heart of a cockroach?
SOLUTION

13 chambers are present in heart of a cockroach, out of which 10 chambers are in abdominal region and 3 are in thoracic region.